Interdisciplinary Thermal/Stress Analysis

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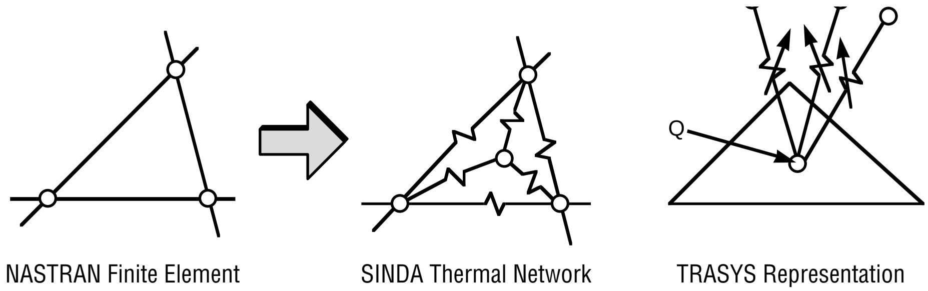

FIGURE 71.—NASTRAN to SINDA/TRASYS conversion.

A computer program was developed to convert NASA structural analyzer (NASTRAN) stress models to thermal radiation analysis system (TRASYS) and systems improved numerical differencing analyzer (SINDA) thermal models in support of the next generation space telescope (NGST) project. The NGST concept employed an exposed 8-m-diameter primary mirror that was subdivided into eight independently actuated petals. The primary mirror was blocked from the Sun on one side by an external light shade. Accurate determination of thermal deflections in the primary mirror induced by spacecraft attitude changes as well as by the difference between ground and on-orbit environments was essential to assess the feasibility of the project.

The computer program was used to convert the NASTRAN geometrical data (triangular and quadrilateral finite elements) to TRASYS polygons. The finite element mesh was converted to a mathematically equivalent thermal network that, along with the output from the radiation analyzer, was solved by SINDA. Internal structure, included as NASTRAN bar elements, was not modeled radiatively with TRASYS, but was included in the SINDA thermal network solution as conductors derived from effective cross-sectional area and length. The conversion process is illustrated in figure 71 as the NASTRAN nodal points become “arithmetic” nodes in the SINDA thermal network. A diffusion node is added corresponding to the centroid of the element, providing a convenient location to impose heat loads and thermal mass and to attach radiation conductors.

The resulting thermal models were able to provide a one-to-one nodal correspondence between the thermal and stress models while accounting for the thermal conductance within the primary mirror and radiation exchange between all surfaces. Thermal analysis predictions from the correlated thermal/stress models are shown in figure 72.

Sponsor: MSFC Preliminary Design Office

Biographical Sketch: Greg Schunk received his bachelor’s degree in mechanical engineering in 1983. He has worked at NASA’s Marshall Space Flight Center for 13 years. His experience includes thermal analysis/heat transfer modeling for a number of projects including Spacelab, the *International Space Station*, and AXAF. He also supported the initial design and development of the *International Space Station* Environmental Control and Life Support System (ECLSS) test-bed.

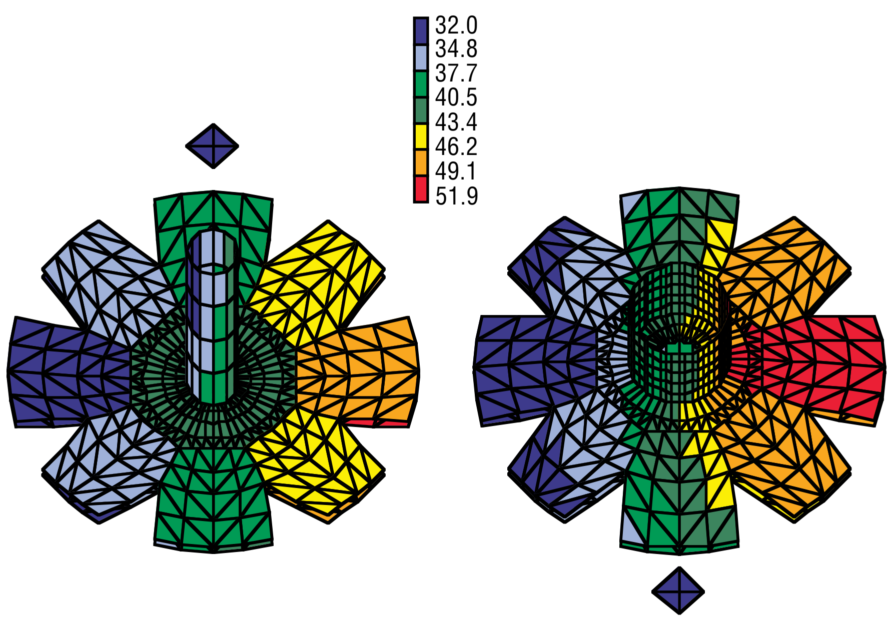

FIGURE 72.—NGST thermal analysis predictions (K).